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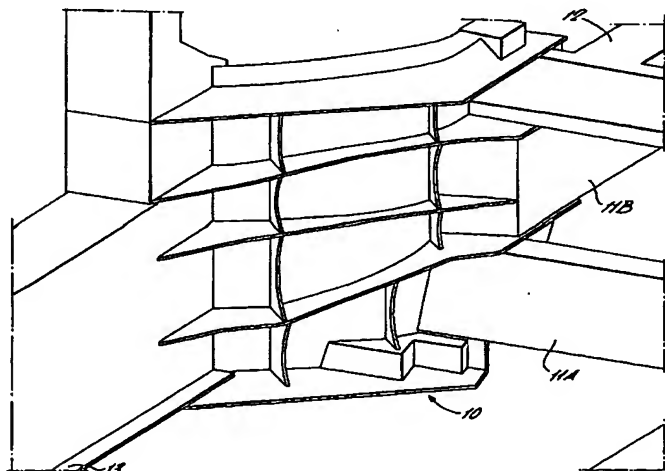
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(54) Title: A METHOD OF MANUFACTURE OF AN AUTOMOBILE STRUCTURE AND AN AUTOMOBILE STRUCTURE MADE BY THE METHOD



(57) Abstract: With reference to Figure 1, the present invention provides a method of manufacture of an automobile structure comprising the steps of: forming in a die a plurality of castings (10) each having at least one socket (14); forming a plurality of metallic rails (12, 13) and fixing the metallic rails (13, 14) in the socket of the castings (10) in order to construct the automobile structure. The present invention also provides a method of manufacture of a plurality of different automobile structures, the method comprising: fixing metallic rails of a first plurality into sockets of a first plurality of the castings to form a first type of automobile structure; and fixing metallic rails of a second plurality into sockets of a second plurality of castings to form a second type of automobile structure. The invention also relates to automobile structures made by the methods.

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A METHOD OF MANUFACTURE OF AN AUTOMOBILE  
STRUCTURE AND AN AUTOMOBILE  
STRUCTURE MADE BY THE METHOD

5           The present invention relates to a method of  
manufacture of an automobile structure and to an  
automobile with a structure made by the method.

10           Automobile structures such as rolling chassis,  
chassis tubs and other types of platform have  
traditionally been constructed by methods which make  
variations very difficult. Different automobiles may  
share a common platform, but the platform itself is of  
15           a fixed shape and configuration. Whilst this has  
suited the needs of mass automobile manufacture the  
known methods are not ideal for low volume  
manufacturers because of their inflexibility.

20           The present invention provides in a first aspect  
a method of manufacture of an automobile structure  
comprising the steps of:

          forming in a die a plurality of castings each  
having at least one socket;

25           forming a plurality of metallic rails; and  
fixing the metallic rails in the sockets of the  
castings in order to construct the automobile  
structure.

30           The present invention provides in a second aspect  
a method of manufacture of a plurality of different  
automobile structures comprising:

          forming in a die a plurality of identical  
castings each having at least one socket;

35           forming a first length of metal of a first chosen  
cross-section;

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cutting the first length of metal into a first plurality of side rails for an automobile each with the same first side rail length;

5 cutting the first length of metal into a second plurality of side rails for an automobile each with the same second side rail length different to the first side rail length;

fixing the metallic rails of the first plurality into sockets of a first plurality of the castings to form a first type of automobile structure; and

10

fixing the metallic rails of the second plurality into sockets of a second plurality of castings to form a second type of automobile structure.

15 A preferred method of manufacture of an automobile structure will now be described with reference to the accompanying drawings which show component parts used in the method as follows:

Figure 1 shows a first assembled joint of an automobile structure according to a method of the present invention;

20

Figure 2 is a first detail view of a part of the joint illustrated in Figure 1;

Figure 3 is a second detail view of a part of the Figure 1 joint;

25

Figure 4 is a third detail view of the joint of Figure 1;

Figure 5 is a first view of a structural member for use in a method of manufacture according to the present invention;

30

Figure 6 is a second view of the structural member of Figure 5;

Figure 7 is a first view of a second assembled joint of an automobile structure manufactured according to the present invention;

35

Figure 8 shows a second view of the assembled joint of Figure 7; and

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Figure 9 is a schematic plan view of an automobile structure made by a method according to the present invention which has structural members as shown in Figures 5 and 6 and has joints as shown in Figures 7 and 8.

Turning first to Figure 1 there can be seen a casting 10 to which are joined a front bulkhead of a vehicle (comprising a transverse rail 11A and transversely extending support structure 11B), a side rail 12 and a side rail 13. The transverse rail 11A and the side rails 12 and 13 are extrusions, typically of an aluminium alloy. The side rail 12 extends rearwardly of the first bulkhead to join the casting 10 to another similar casting (not shown) to which is attached a rear bulkhead (not shown, but similar to the front bulkhead 11A and 11B). The side rail 13 extends forwardly of the first bulkhead to provide support for an engine (on a front-engined vehicle), the crash structure of the vehicle (not shown) and one of the front suspension assemblies of the vehicle (not shown). The side rails 12, 13 and the transverse rail 11A are all bonded to the casting 10.

Figure 2 shows in detail a part of the casting 10. The casting 10 has as an integral feature a socket 14 open in two perpendicular directions having a pair of parallel spaced apart planar surfaces 15 and 16. The side rail 12 is a box section extrusion (see Figure 3). The front end of the side rail is cut at an angle to leave a pair of parallel spaced apart planar surfaces 17 and 18. The planar surface 18 is formed from part of a surface which was initially an interior surface of the box section extrusion, prior to cutting of the extrusion.

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The planar surfaces 17 and 18 are respectively adhered to the planar surfaces 15 and 16 of the open socket 14. The resulting joint can be seen in Figure 4. A cover (not shown) will be fixed across the joint to close the socket in one direction.

A second embodiment of casting 30 is shown in Figures 5 and 6. The casting 30 is simplified in comparison with the casting 10. It has a socket section 31 open in two perpendicular directions, as an integral feature. The socket section 31 has a flat surface to allow good adhesion of a side rail in the socket section 31. The remainder of the casting 30 has surface ribbing to provide good strength. A flange 32 extends from the upper edge and around the front edge. In Figure 5 it can be clearly seen that the socket section 31 of the casting 30 immediately after casting has a stepped height feature. A part of the socket section 31 nearest the rearward edge has a first height  $h_1$  and then a part inward of the rearward edge has a second greater height  $h_2$ . This feature is arranged to provide the casting with a degree of flexibility. A designer for a first vehicle may choose to have a side rail with a first sill height  $h_1$  while for a second vehicle a larger sill height  $h_2$  may be required. A simple cutting operation can convert the open socket 31 from a socket for receiving a sill of height  $h_1$  to a socket for a sill of height  $h_2$ . Thus in a method according to the present invention a single casting is provided with a number of different features, e.g. socket heights which will not all be used in a single automobile structure. Instead a selection can be made.

Figures 7 and 8 show the casting 30 in use.

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First of all it will be seen that the lower height part of the socket section 31 has been removed. A generally L-shaped side rail 37 is adhered in the open socket section 31. A floor section 33 of the automobile structure is adhered to a flange 34 extending from the lower edge of the casting 30 (see Figure 8). Ghosted in the Figure 7 is an "A" pillar support structure 39. Forward of the "A" pillar support structure 39 a sheet metal cover plate (not shown) will be adhered to the flange 32 of the casting 30 and to a flanged edge 35 of the floor section 33 (see Figure 7). Thus, two sides of a box are defined by the casting 30 and two sides by the floor section 33 and the cover plate (not shown) (both made from sheet metal). A sheet metal plate 36 can be seen adhered to a flanged edge of the floor section 33, to the flange 32 of the casting 30 and to an edge of the L-shaped side rail 37.

The casting 30 is shaped to curve inwardly towards the centre of the vehicle structure. The lateral distance by which the front edge is displaced from the rear edge will be varied from casting to casting. In extremis, the displacement can be such as to give the arrangement shown schematically in Figure 9. In the figure two castings 30 help to define a floorpan for a 'diamond shaped' seating arrangement in which a driver 40 sits foremost, two passengers 41, 42 sit both laterally and rearwardly displaced from the driver 40 and a third passenger 43 sits immediately behind the driver. This can provide a very efficient use of the overall length of a vehicle. The distance  $L_1$  shown in the figure is the distance which must be allowed to provide an adequate crumple zone for a direct frontal impact. For an off-centre impact a

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longer distance  $L_2$  is required. Generally with the conventional driver and passenger side-by-side arrangement the distance  $L_2$  must be allowed across the whole of the vehicle (at the front and the rear) and so the length of the vehicle is the sum of  $2 \times L_2 +$  (room for driver and passenger to sit one behind the other). However, in the new arrangement the length of the vehicle is less because it is the sum of  $2 \times L_1 +$  (room for driver and passenger to sit one behind the other).

The use of open sockets which are closed by closing plates removes the need for high tolerances which can be achieved only by expensive machining processes. The casting 10 and 30 will typically be of die cast aluminium alloy, perhaps of an alloy with magnesium. The castings 10 and 31 function as parts defining the structure and not just as connecting nodes.

The invention recognises that it is best to use aluminium and alloys thereof for components formed either by casting or by extrusion since pressing of aluminium and aluminium alloys is difficult. Nodes with sockets closed in all but one direction used in previous designs have typically been steel pressings.

It is envisaged that the side rails will be first fixed in place in the open sockets in the castings by mechanical fixings such as 'EJOT' screws or bolts. Then adhesive will be injected into defined gaps (perhaps of depths defined by surface features on the castings and/or the extrusions). The mechanical fixings will be left in place to prevent peeling of the adhesive.

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The automobile structure formed by the method described above is a self-supporting structure which provides the primary strength to the automobile and is not simply supply a cladding structure. Bodywork .  
5 cladding will be joined to and supported by the structure formed by the invention.

The method of the present invention allows great flexibility in design of an automobile structure  
10 because the side rails and the transverse rails are formed by cutting sections from long extrusions. The sections can be of any chosen length. The cast nodes are common to all designs. Thus without any additional tooling expenditure the designer can choose  
15 long length extrusions for the longitudinal side rails of a four/five passenger vehicle and shorter length extrusions as the side rails of a two-seater vehicle. Similarly transverse rails can be chosen to have different lengths so that the vehicle width can easily  
20 be varied. Also, as mentioned above, by designing in each casting the possibility for different size sockets a large section extrusion can be chosen for a high-silled off-road vehicle while a small section extrusion can be chosen for a low-silled sports car.

25

Whilst in the above description the side rails are formed as aluminium extrusions, it is possible that the side rails could be formed by pressing and/or  
folding, particularly if the side rails are formed of  
30 steel, which lends itself to pressing and folding operations. When steel is used then spot welding is conveniently used to fix each side rail to a casting.

## CLAIMS

1. A method of manufacture of an automobile structure comprising the steps of:
  - 5 forming in a die a plurality of castings each having at least one socket;
  - forming a plurality of metallic rails; and
  - fixing the metallic rails in the sockets of the castings in order to construct the automobile
  - 10 structure.
2. A method as claimed in claim 1 wherein:
  - four of the castings are formed which in the finished structure are located one each at the four
  - 15 corners of a generally rectangular cabin of the automobile; and
  - two of the metallic rails are side rails which extend longitudinally parallel to each other on opposite sides of the cabin each between a different
  - 20 pair of castings, each side rail being fixed at each end in socket of a casting.
3. A method as claimed in claim 1 or claim 2 which additionally comprises:
  - 25 forming at least one of the castings initially with features capable of defining a plurality of different sizes of sockets;
  - selecting a size of cross-section of a metallic rail; and
  - 30 machining the said at least one casting to provide the casting with a socket of a size appropriate for the selected metallic rail.
4. A method as claimed in any one of the preceding
- 35 claims wherein each of the plurality of metallic rails is formed from an extrusion.

5. A method as claimed in any one of the preceding claims comprising fixing the metallic rails in the sockets by bonding with adhesive.

5

6. A method as claimed in claim 5 wherein the metallic rails are initially secured in place in the sockets by mechanical fasteners and then adhesive is injected in gaps left between the rails and the sockets.

10

7. A method as claimed in any one of the preceding claims, wherein each socket formed in each casting is open in two perpendicular directions.

15

8. A method as claimed in claim 7 wherein a closing plate is used to complete each socket.

20

9. A method as claimed in claim 5, 6 or 7, comprising:

forming in at least one of the castings a socket having a pair of parallel spaced apart planar surfaces extending between side walls common to both;

25

forming a rectangular cross-section hollow metal rail;

cutting away three of the four walls from an end section of the hollow metal rail to leave exposed a planar surface which was originally an interior surface of the hollow metal rail; and

30

adhering the exposed planar surface of the metal rail to one of the parallel spaced apart planar surfaces of the casting and adhering to the other planar surface of the casting a part of an exterior surface of the hollow rail which is parallel to and spaced apart from the exposed planar surface of the hollow rail.

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10. A method as claimed in any one of claims 1 to 3 wherein each metallic rail is formed from steel by pressing and/or folding.

5 11. A method as claimed in claim 8 comprising fixing the metallic rails in the sockets by welding.

12. A method as claimed in claim 10 or claim 11 wherein each socket formed in each casting is open in  
10 two perpendicular directions.

13. A method as claimed in claim 12 wherein a closing plate is welded to each casting to complete each socket.  
15

14. A method as claimed in claim 11 or claim 12, comprising:

forming in at least one of the castings a socket having a pair of parallel spaced apart planar surfaces  
20 extending between side walls common to both;

forming a rectangular cross-section hollow metal rail;

cutting away three of the four walls from an end section of the hollow metal rail to leave exposed a  
25 planar surface which was originally an interior surface of the hollow metal rail; and

welding the exposed planar surface of the metal rail to one of the parallel spaced apart planar surfaces of the casting and welding to the other  
30 planar surface of the casting a part of an exterior surface of the hollow rail which is parallel to and spaced apart from the exposed planar surface of the hollow rail.

35 15. A method as claimed in any one of claims 1 to 8

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or 10 to 13 wherein at least one metallic rail is formed as an open-section rail and in the method a cover plate is fixed to the open-section metallic rail to close the section.

5

16. A method as claimed in claim 15 wherein the open-section rail is fixed additionally to a floor panel and the cover plate is fixed to both the floor panel and the metallic rail in order to form a closed-section structure extending along a side of the vehicle.

10

17. An automobile comprising a chassis formed by the method of any one of the preceding claims, the chassis providing the primary structural rigidity of the vehicle and the automobile having exterior body panels overlaying the chassis.

15

18. An automobile as claimed in claim 17 which has a cabin with a diamond shaped floor pan and seats for a driver and three passengers; a driver's seat located forward of the other seats and centrally widthwise of the vehicle; two passengers' seats located rearwardly of the driver's seat and each spaced transversely outwardly from the driver's seat; and a fourth passenger seat located rearwardly of the other three seats and directly behind the driver's seat.

20

25

19. A method of manufacture of a plurality of different automobile structures comprising:  
forming in a die a plurality of identical castings each having at least one socket;  
forming a first length of metal of a first chosen cross-section;

30

cutting the first length of metal into a first plurality of side rails for an automobile each with the same first side rail length;

35

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cutting the first length of metal into a second plurality of side rails for an automobile each with the same second side rail length different to the first side rail length;

5       fixing the metallic rails of the first plurality into sockets of a first plurality of the castings to form a first type of automobile structure; and

      fixing the metallic rails of the second plurality into sockets of a second plurality of castings to form  
10       a second type of automobile structure.

20. A method as claimed in claim 19 wherein the castings are each formed with features defining a first size of socket and with features capable of  
15       defining a second different size of socket, and the method additionally comprises:

      forming a second length of metal of a second chosen cross-section;

      cutting the second length of metal into a third plurality of side rails for an automobile each with  
20       the same third side rail length;

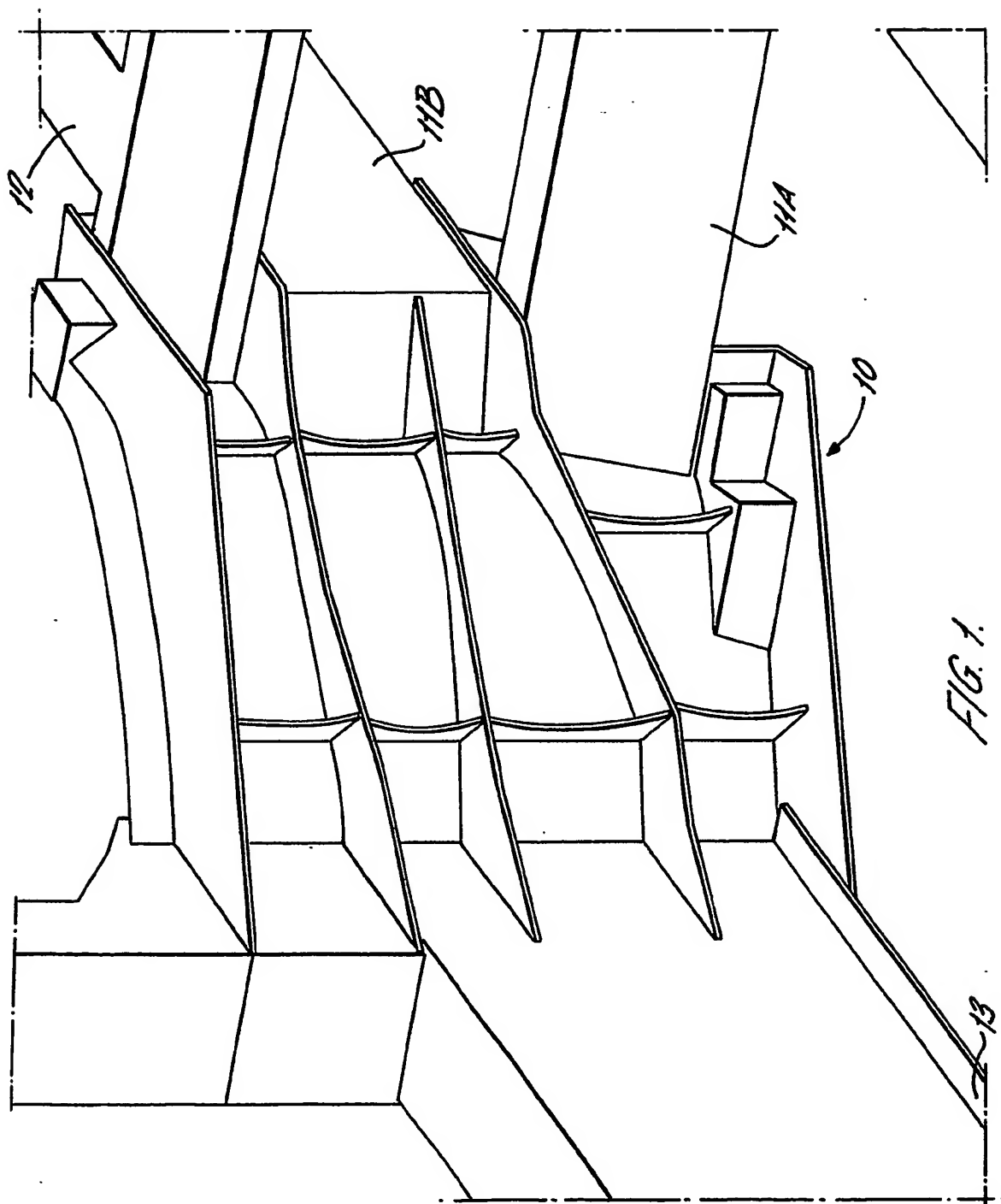
      cutting the second length of metal into a fourth plurality of side rails for an automobile each with the same fourth side rail length different to the  
25       third side rail length;

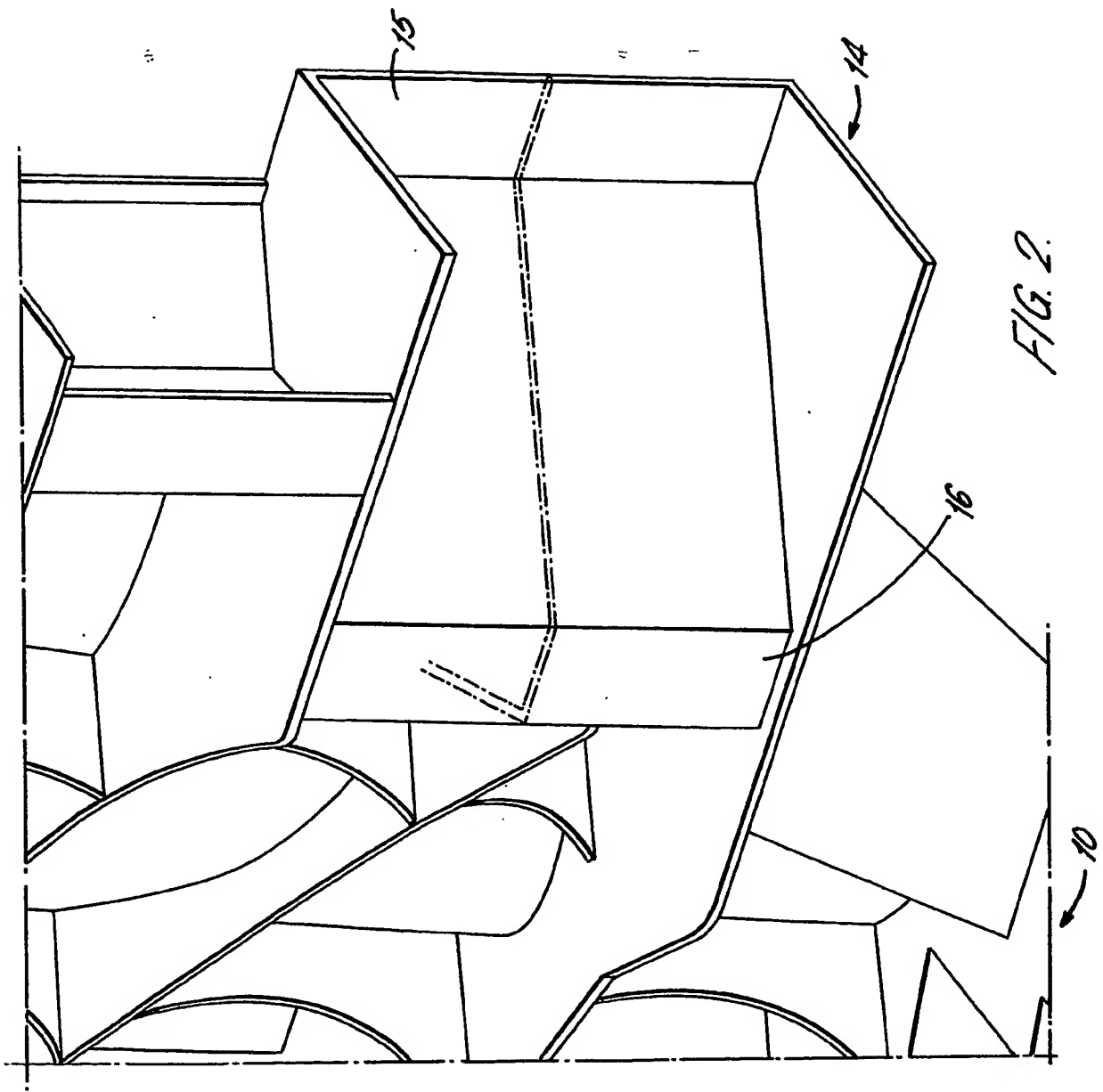
      machining after casting some of the identical castings to provide a first plurality of the castings with sockets of the second size, while leaving others of the identical castings unmachined to provide a  
30       second plurality of castings with sockets of the first size; and

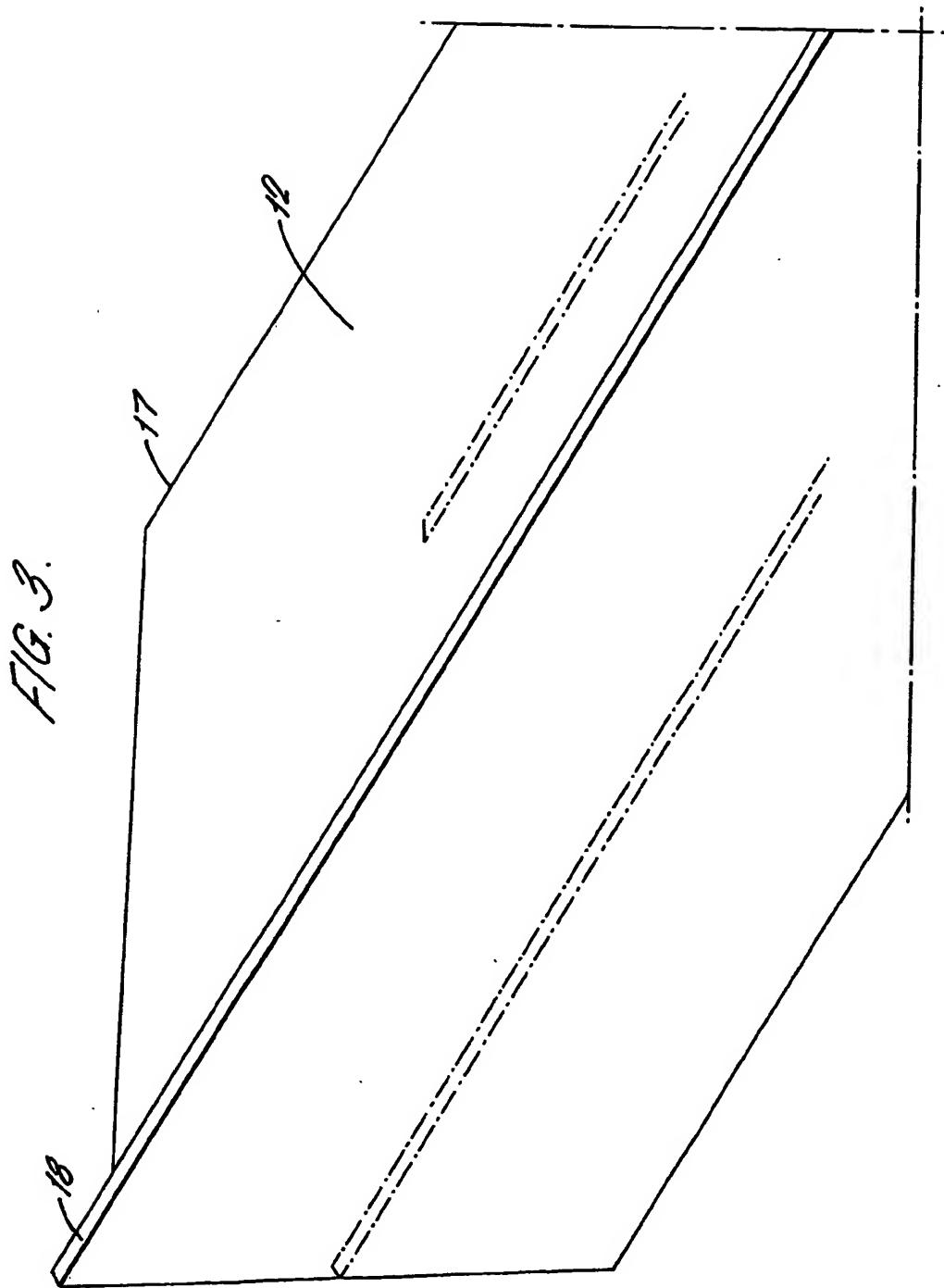
      selecting between the plurality of castings and the plurality of side rails and fixing side rails into the sockets of the castings where the sizes of the  
35       sockets of the castings match the cross-sections of the side rails in order to form a plurality of

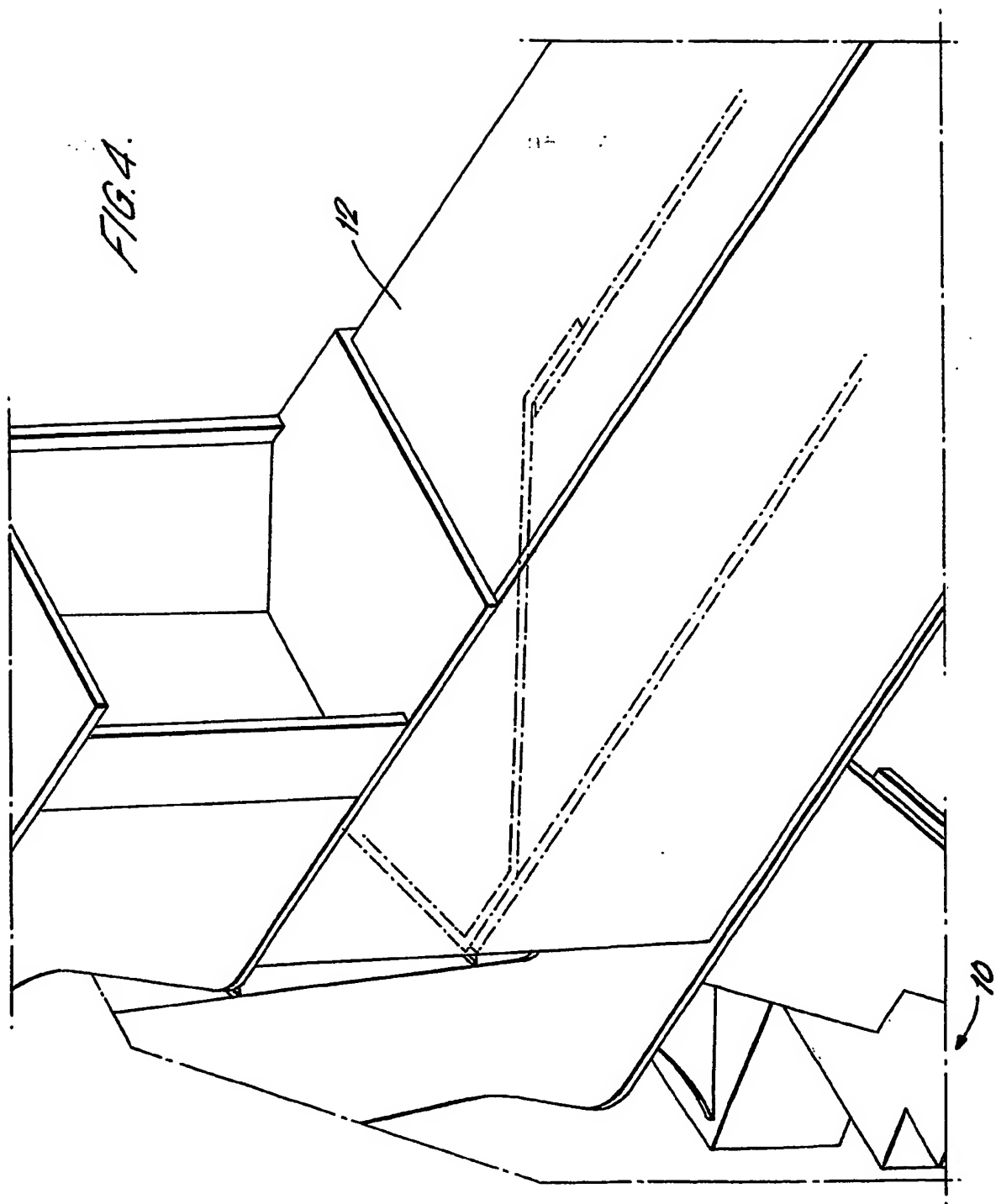
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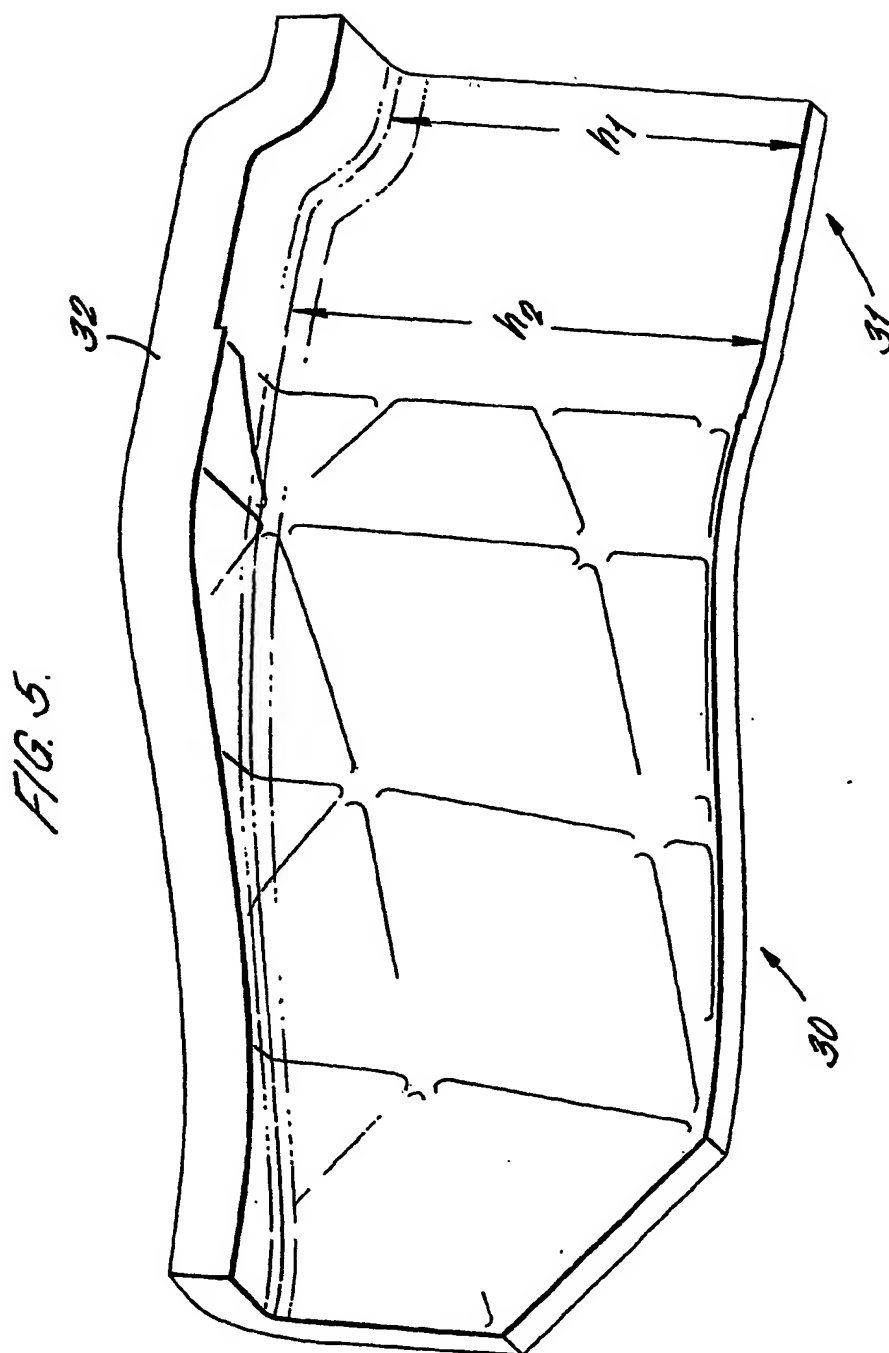
different automobile structures from a common set of initial castings and metallic railings.











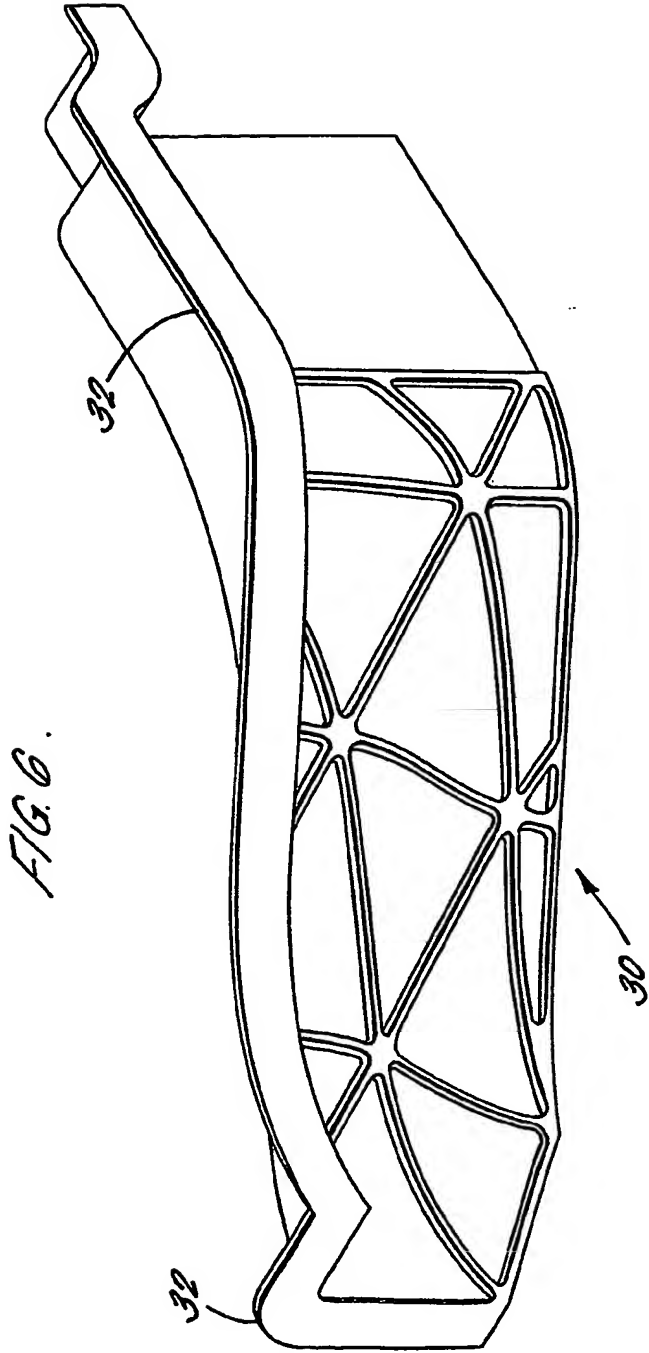
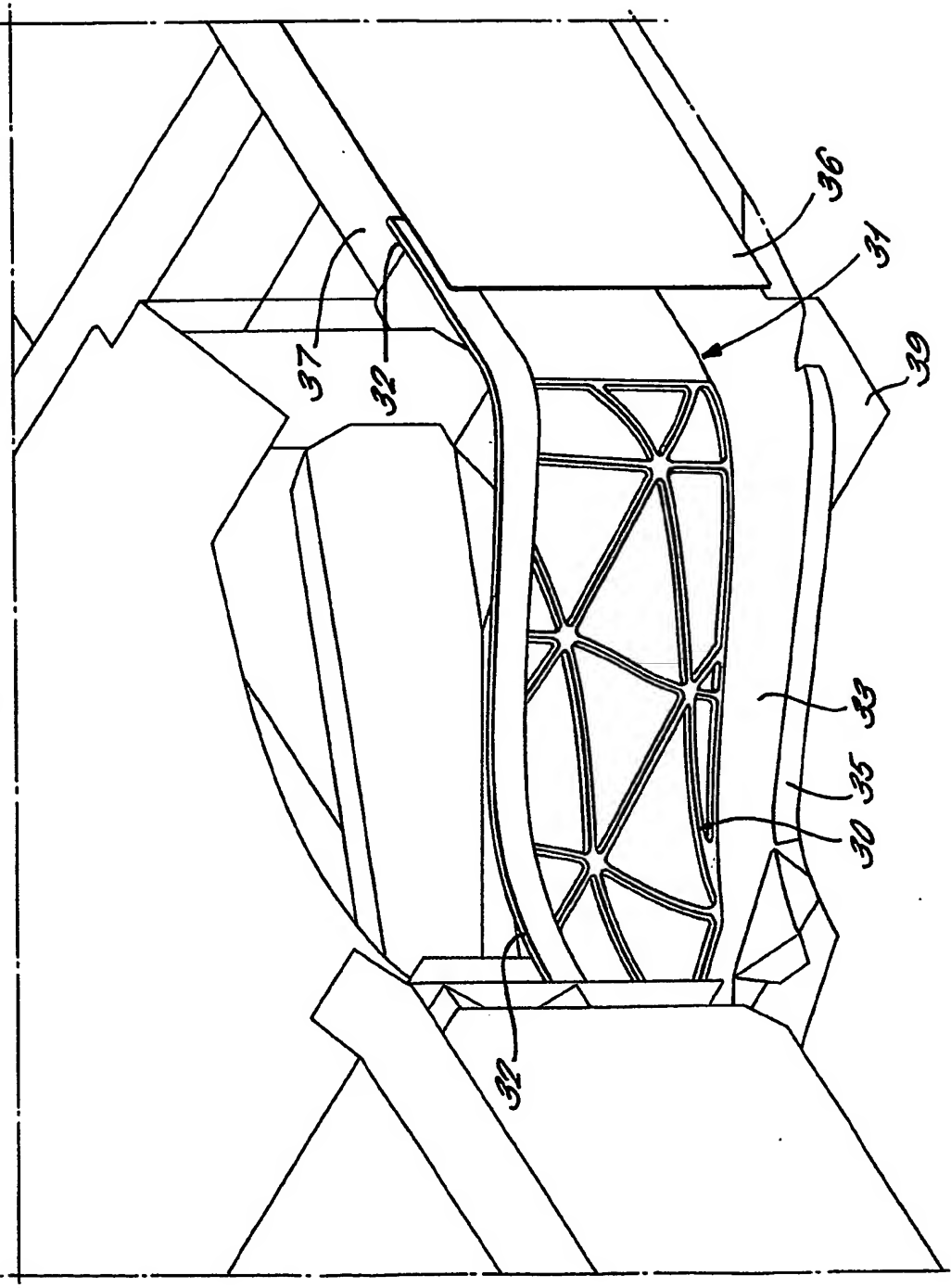


FIG. 7



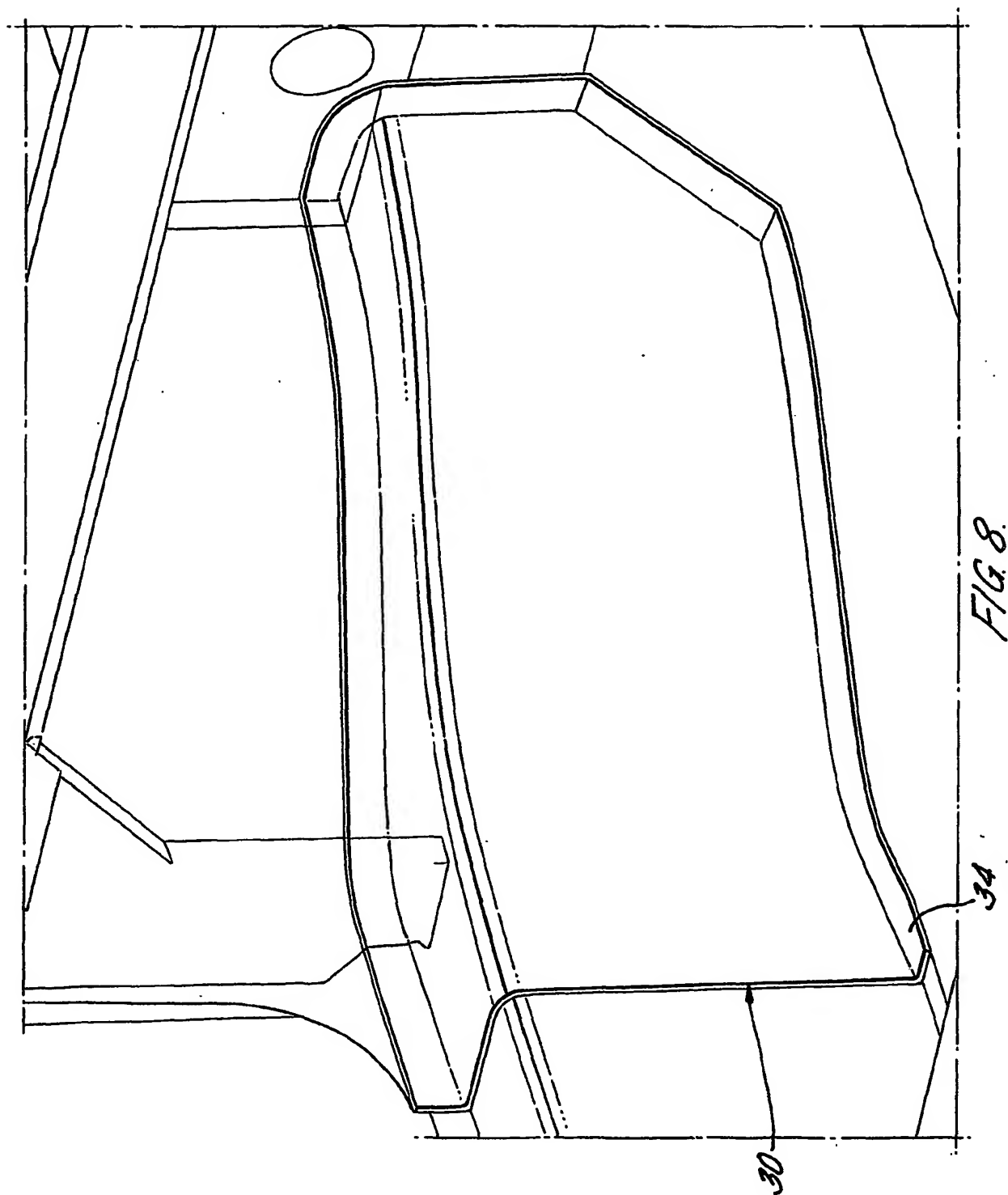


FIG. 9.

